

The Impact of and Response to Climate Change from the Perspective of the Trinidad and Tobago Electricity Commission'

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Summary of Presentation

- ❖ Introduction to T&TEC
- ❖ Climate Change and challenges faced by the electricity industry.
- ❖ Addressing Climate change – T&TEC initiatives

Trinidad and Tobago Electricity

Commission

- T&T.E.C. is State owned and is the sole Transmission and Distribution Electric Utility in T&T. T&TEC has over 420,000 customers and sells in excess of 9,410 GWh per year and is responsible for supplying fuel to its three IPP's through a Gas Tolling arrangement. T&TEC is given the highest priority for gas supply from its supplier the NGC.
- T&TEC is responsible for Generation Planning and the administration of four PPA's. The current system peak demand is 1,348MW
- Our customers enjoy some of the lowest tariffs in the region at an average price of 6.0US cents per kWh. T&TEC is required by law to comply with various Service and Overall standards determined by its regulator , the Regulated Industries Commission (RIC)
- Our customers are metered through an AMI system and to perform its mandate, T&TEC has some 2,700 employees.



Climate Change

Climate Change refers to any significant change in the measures of climate lasting for an extended period of time. In other words, climate change includes major changes in temperature, precipitation (rainfall), or wind patterns, among other effects (snow etc), that occur over several decades or longer.

(Source: US EPA website – accessed 31st March 2015)

Climate Change

Earth's average temperature has risen by 1.4°F over the past century, and is projected to rise another 2 to 11.5°F over the next hundred years. Small changes in the average temperature of the planet can translate to large and potentially dangerous shifts in climate and weather.

Gas name	Chemical formula	Global warming potential (GWP) relative to CO ₂ for given time horizon
Carbon dioxide	CO ₂	1
Methane	CH ₄	72
Nitrous oxide	N ₂ O	289
CFC-12	CCl ₂ F ₂	11 000
HCFC-22	CHClF ₂	5 160
Tetrafluoromethane	CF ₄	5 210
Hexafluoroethane	C ₂ F ₆	8 630
Sulfur hexafluoride	SF ₆	16 300
Nitrogen trifluoride	NF ₃	12 300



Impacts of Climate Change

- Scientists have confirmed that climate change is underway and the effects include but are not limited to: increasing global temperatures, extremes of rainfall and drought, as well as rising sea levels to name a few.
- Climate change has the potential to impact negatively on electric utility Generation and Transmission operates. The effects can be crippling to commercial activities, domestic and other institutions, health and National security. All of which can destabilise a society and even lead to the downfall of governments if vision and foresight is not applied

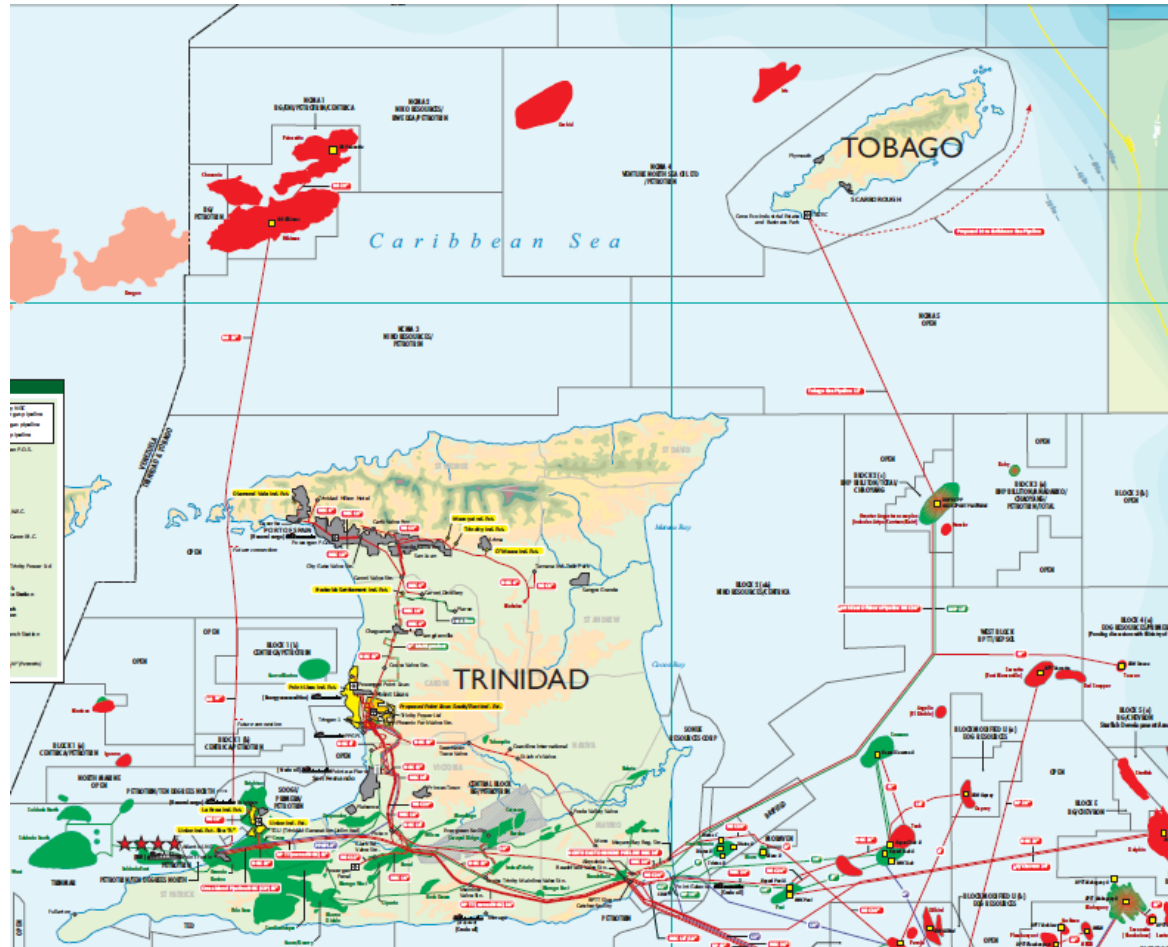
Key challenges the electricity industry faces due to environmental changes

- **Impact on Electric Utilities:**

- In the Caribbean, abnormal wind and rains can cause damage and extended power outages on the largely Overhead Transmission and Distribution systems. Fallen trees and lightning activity present dangerous challenges in the efforts to restore power.
- The other extreme of extended dry season weather results in bush fires and damage to wooden poles and PVC insulated equipment such as fiber optic cables and the like.
- Ionized particulate associated with fires in Trinidad's cane fields (now abandoned) present a perennial threat to high voltage power Transmission lines resulting in large scale outages
- Events like these not only result in losses in revenue but increases insurance premiums to utilities across the region.
- Storms and associated flooding has caused damage to assets including inventory, decreased operational efficiency and availability.
- These events in turn will disrupt the entire economic supply chain for goods and services with a potential inflationary effect.

Natural Gas Infrastructure

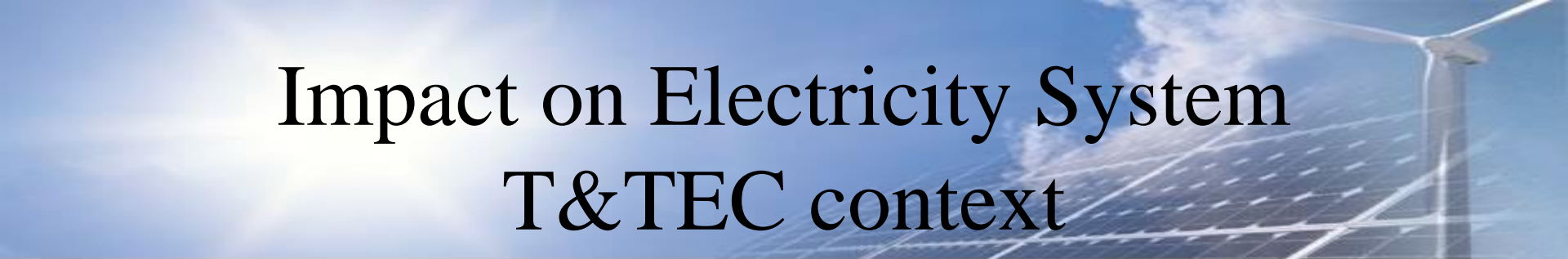
- Considerable natural gas infrastructure is situated off the shores of T&T.
- During sudden changes in environmental conditions, many of these platforms may be left unmanned
- Many of these natural gas pipelines are line packed to allow for generation to continue for a considerable time during these emergency situations
- In Tobago, T&TEC has two diesel storage tanks (2x1.5 million litres) capacity as backup fuel for the Cove Power Station



Key challenges faced by T&TEC due to environmental changes

- **Stress on water resources:**

- Changes in the weather coming at a time of forecasted increases in demands for electricity in Trinidad and Tobago is placing pressure on the available supply of fresh water resources. Of note is the fact that power generation requires a significant amount of water for condenser cooling (open system) as well as closed cooling such as reciprocating engines and gas turbines with nitrogen oxide emission control systems.
- While natural gas may be readily available (at this time), the electricity and industrial sectors demand for water will always run second to that of domestic and other small users for example, agriculture, drinking water, and food processing.
- The increased demand for water can only now come from desalination and T&TEC can account for some 33MW of additional load over the period 2013 to 2017



Impact on Electricity System T&TEC context

Accelerating sea level rise

- Global average sea level has increased eight inches (20cm) since 1880, and is projected to rise up to an additional 6.6 feet (2m) over the course of this century, greatly increasing coastal flooding risks.
- In T&TEC, flooding has caused significant damage to substation equipment in the past. Local example can be seen of flooding at the Harmony Hall substation

Impact on Electricity System T&TEC context

Accelerating sea level rise



Equipment damage – Protection relays, back up battery banks and battery charger and communication devices

Cost of Damages – TT\$1 Million


Impact on Electricity System T&TEC context

Accelerating sea level rise

The Bamboo 132/66 kV substation

- Major substation which electrically links the West and East of Trinidad to Central Trinidad
- Located at the banks of Caroni River
- Perennial rainfall causes banks of Caroni River to overflow which has affected operations to this substation in the past
- Plans are in place to develop a substation at El Socorro/Barataria to install two new 132/66 kV 100 MVA Transformers





Impact on Electricity System T&TEC context

Droughts and reduced water supplies

There were two recent local examples that affected the electricity system. During these two periods, water levels at the Mora Dam in Penal had reduced to low levels that Combined Cycle generation was disrupted.

Impact on Electricity System T&TEC context

Droughts and reduced water supplies



Mora Dam, Penal at full capacity
Over 9m water level (209 days of supply
of water (full capacity) – **December
2014**



Mora Dam, Penal at zero capacity
PowerGen reported that there was no water to
run Penal No. 9 – **July 2014**

Impact on Electricity System

T&TEC context

Elevated water temperatures

- Higher air temperatures warm the water in rivers and reservoirs/dams used by power plants for their cooling needs.
- If the temperature of incoming water is too hot, or if the temperature of the discharge water is too high, power plants must dial back production or worse case shut down temporarily

National Climate Change Policy (NCCP), 2011

- Trinidad and Tobago, is a ratified signatory to the United Nations Framework Convention on Climate Change (UNFCCC) and its Kyoto Protocol
- It is committed under Article 4 of the UNFCCC to reduce or prevent anthropogenic emissions of GHGs not controlled by the Montreal Protocol in all relevant sectors, including the energy, transport, industry, agriculture, forestry and waste management sectors.
- The National Climate Change Policy (NCCP) specifically references RE in Section 9.2, which states that the Government shall increase the use of RE by developing a RE policy and standards; and by developing suitable fiscal incentives for domestic use and sale to the national grid.



RENEWABLE ENERGY

GOVERNMENT INVOLVEMENT

- Recommended fiscal incentives

SOLAR
25% Tax Credit on Solar Water Heaters (SWH)
0% VAT on SWH& Solar PV Systems
150% Wear & Tear Allowance for SWH;SWH Plant , Machinery and Equipment, and Solar PV Systems
Conditional Duty Exemptions for SWH Manufacturers.

WIND
0% VAT on Wind Turbines .
150% Wear & Tear Allowance for Wind Turbines and supporting equipment

Energy Efficiency
150% Allowance for the design and installation of energy saving systems by an Energy Service Company(ESCO)
ESCO can write off value of assets in two years: - a)75% Depreciation on plant, machinery and equipment acquisition; b)25% Wear& Tear allowance in following year.



Addressing Climate Change

- To effectively address these growing climate risks and ensure a reliable supply of electricity for years to come planners must take steps today to improve the resilience of electricity infrastructure and reduce the carbon emissions that are driving up the planet's temperature.
- Ramping up renewable energy is a key component of this effort, both to make our electricity system more resilient and reliable in the short-term, and to curb climate change over the long-term.



Addressing Climate Change

Ramping up renewable energy does not only reduce carbon emissions, but is key to creating a more resilient, secure reliable electricity system.

- **Smaller-scale, more distributed power:** Renewable technologies like wind turbines and rooftop solar panels are small, distributed, and often weather storms and heat waves better than conventional power plants.
- **Decreased fuel supply risks:** Most renewable technologies utilize on-site energy sources such as wind and solar power, making them far less vulnerable to interruptions in fuel supplies. In contrast, fossil fuel supplies must be extracted, processed, and transported, a supply chain with many climate-related vulnerabilities.



POWER GENERATION IN TRINIDAD AND TOBAGO

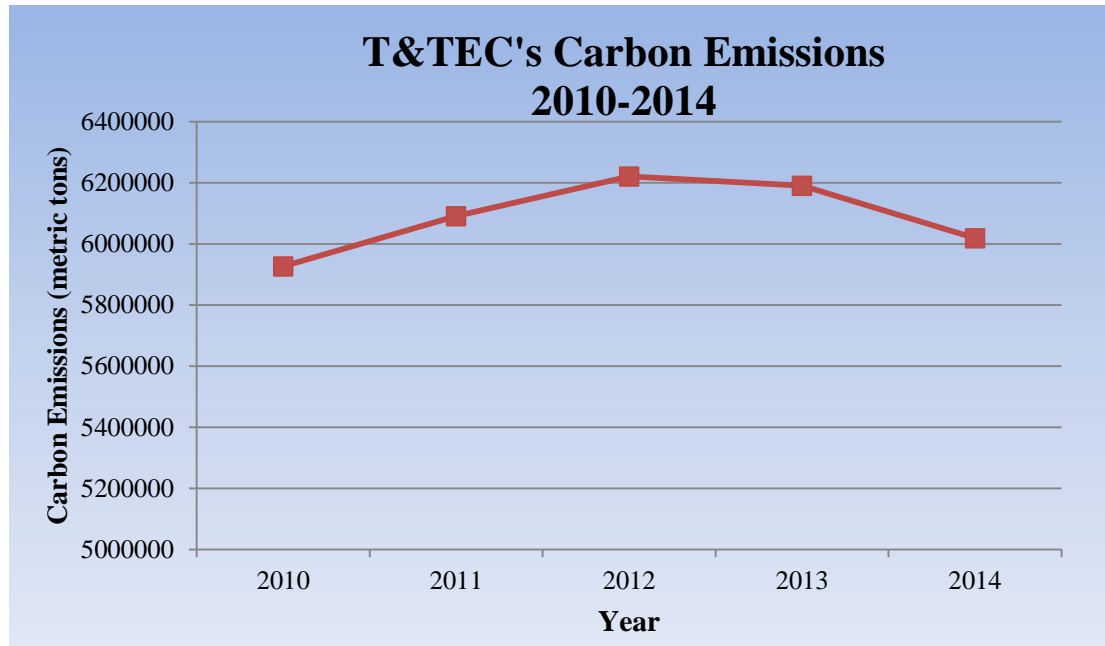
- Primary fuel – Natural Gas
- Cleanest burning fossil fuel (30 % less CO₂ than burning petroleum, 45% less than burning coal)
- CO₂ emission for 2011 was ~ 0.69 kg of CO₂ per kWh
- CO₂ emission for 2014 was ~ 0.64 kg of CO₂ per kWh
- Preferred pricing enables a reduced tariff to customers

Addressing Climate Change

T&TEC Initiatives

Reduction in Carbon Emissions

Year	Carbon Emissions (metric tons)
2010	5,926,000
2011	6,091,000
2012	6,220,000
2013	6,190,000
2014	6,018,000

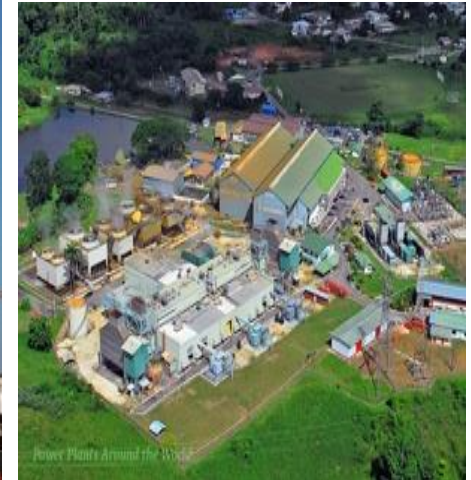



Prior to 2012, a large sector of power generation was done by simple cycle plant with a system efficiency of **26.4% or system heat rate – 13,617 kJ/kWh**).

On 12th December 2012, 2x135 MW Combined Cycle plant were commissioned at the TGU Plant.

This meant a higher reliance on Combined Cycle efficiency resulting in a present system efficiency of **28.8% or system heat rate – 12,523 kJ/kWh**

Power Stations in Trinidad and Tobago





Addressing Climate Change T&TEC Initiatives

Smaller-scale, more distributed power

- As part of Trinidad's drive towards renewable energy, T&TEC, MEEA and the GEI installed three small-scale PV projects (6.4kW) for training purposes
- Regulations have been developed by T&TEC and a draft National FIT Policy has been developed together with tax incentives for investors. The eventual goal is to have individual households and businesses install permanently-connected renewable energy systems

RENEWABLE ENERGY PROJECTS

Solar Power Projects

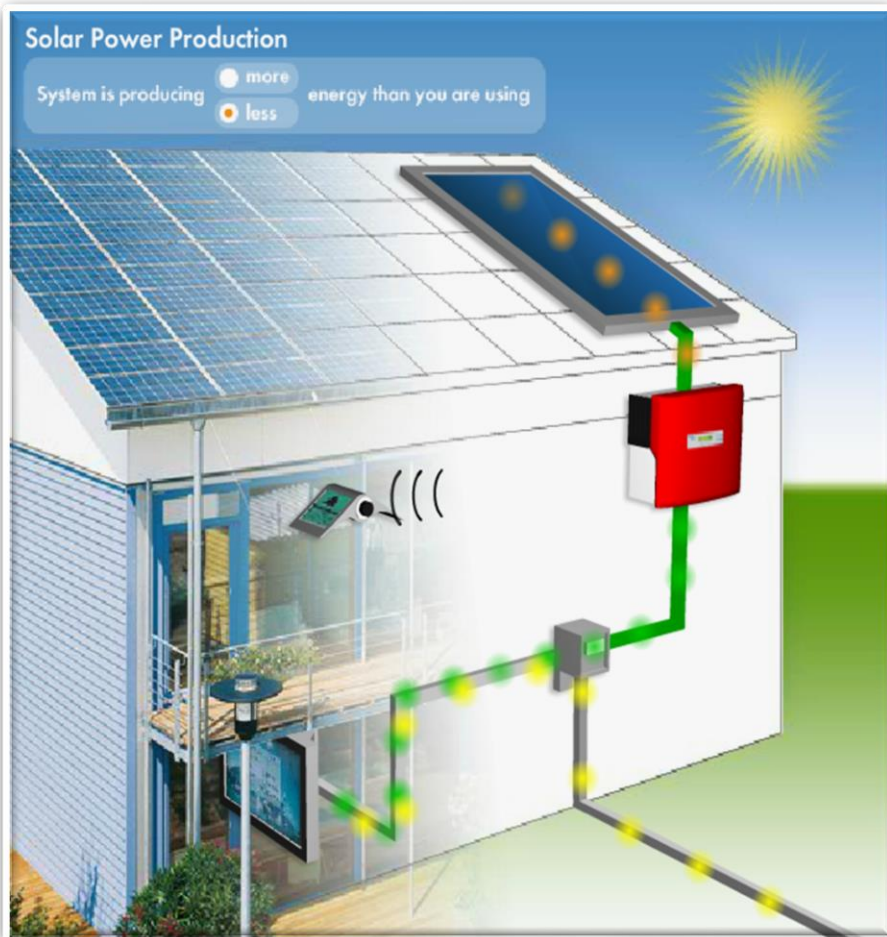


University of Trinidad and
Tobago
O'Meara Campus (2 kW)

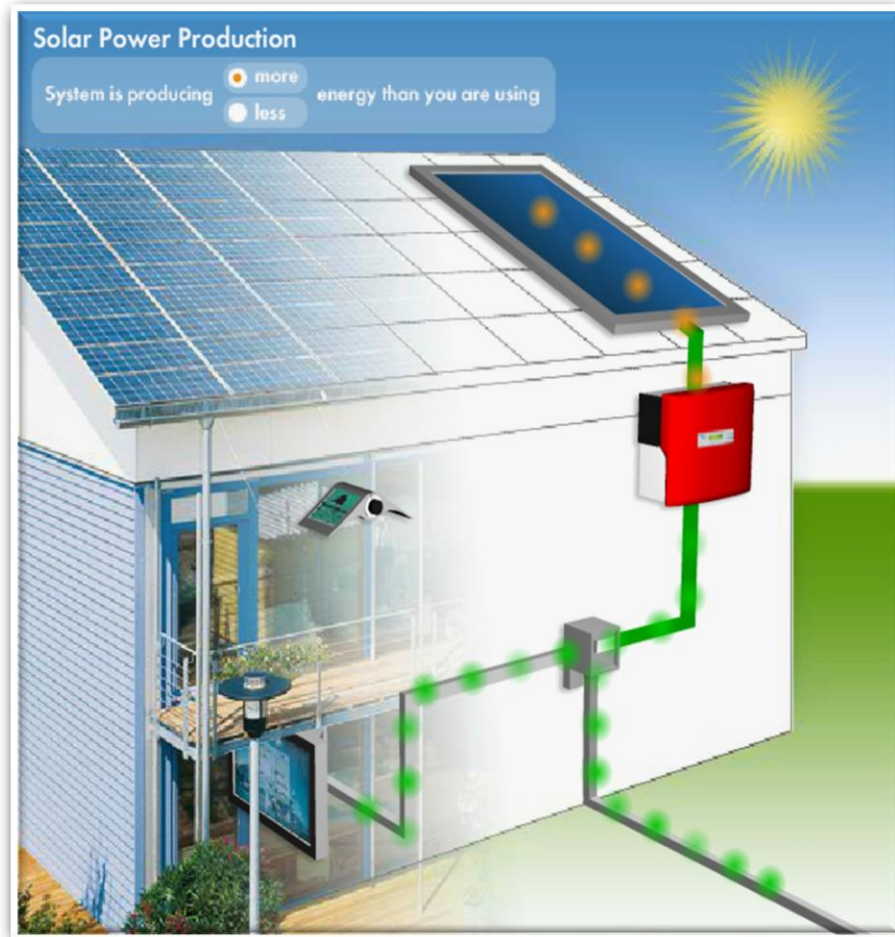


Trinidad and Tobago Electricity
Commission
Mt. Hope Compound (2 kW)

NET METERING

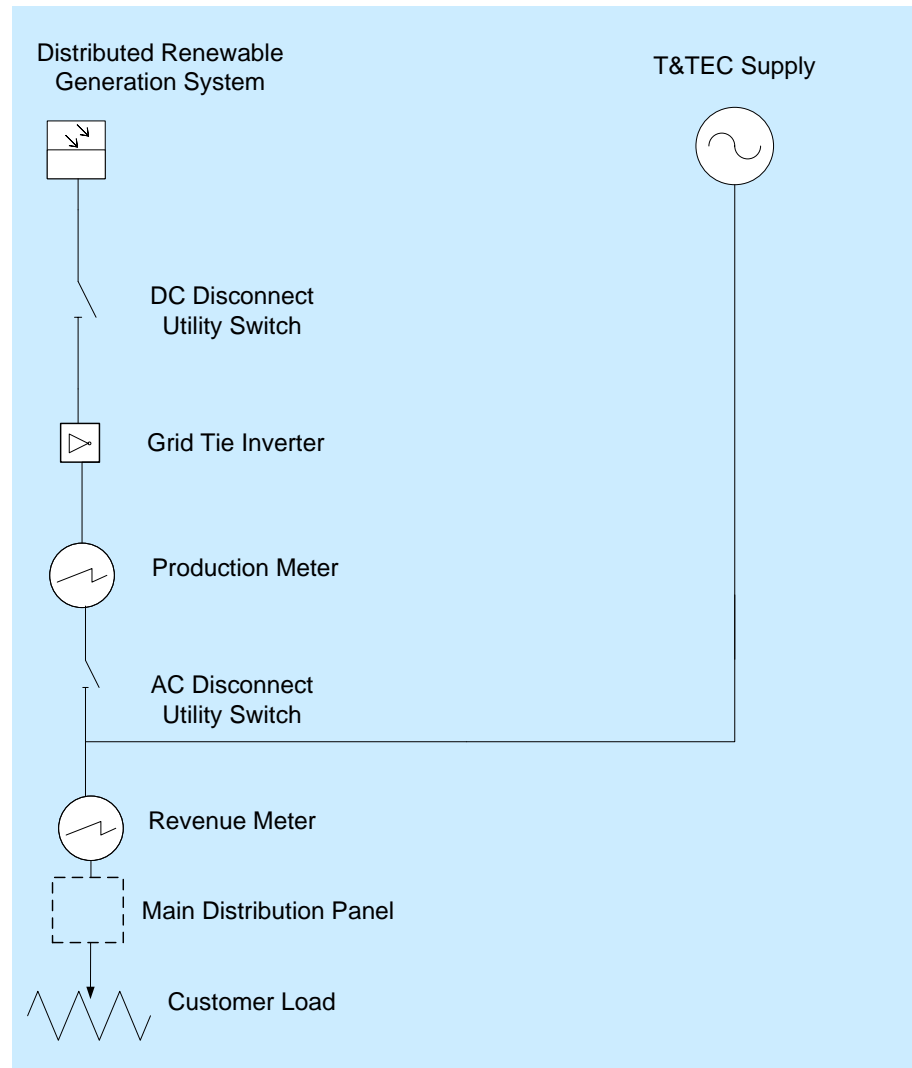


Importing power from grid



Exporting power to the grid

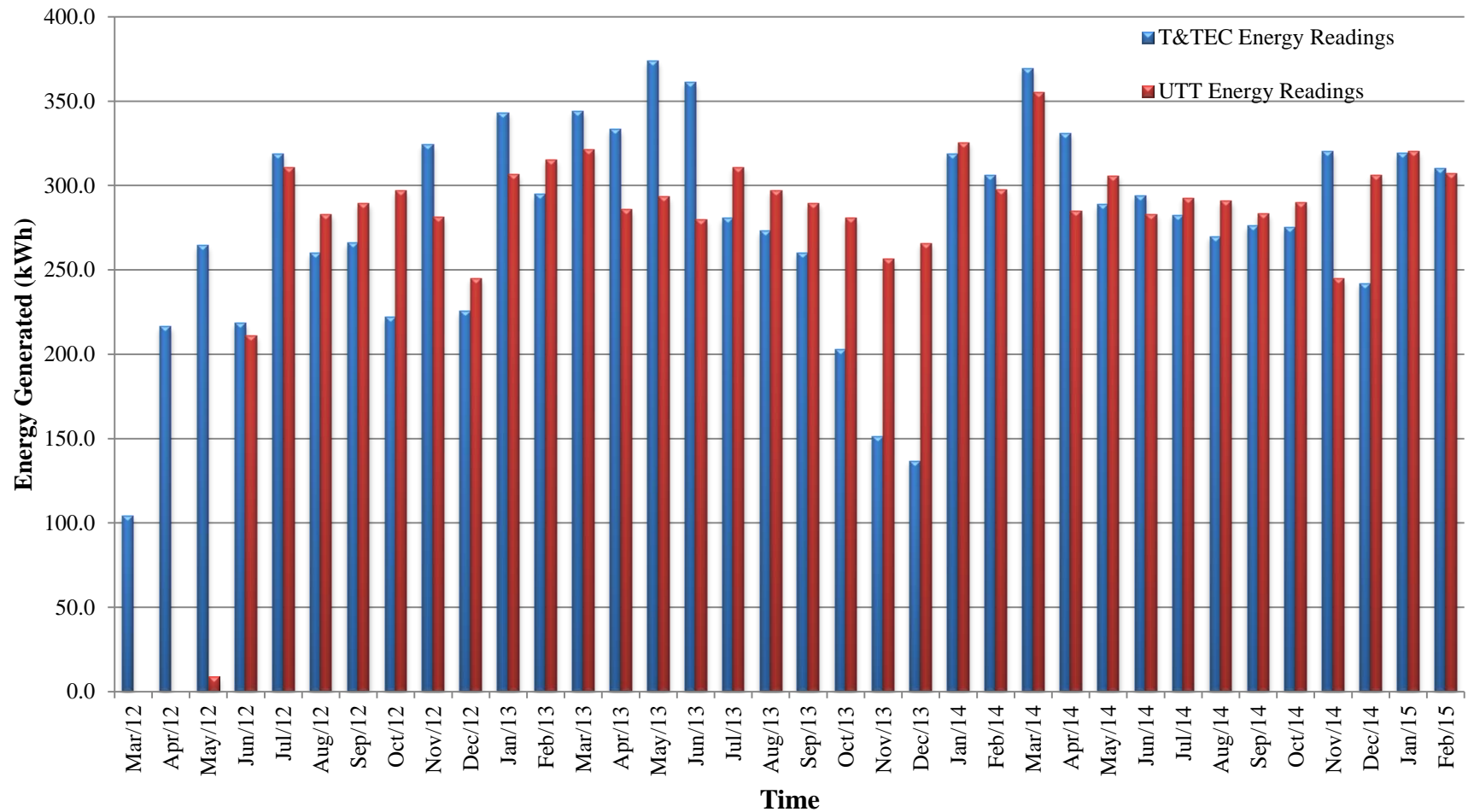
Net Billing Arrangement



Addressing Climate Change

T&TEC Initiatives

Monthly energy generated by PV System at T&TEC vs UTT locations



Summary of T&TEC'S Grid Interconnected RE Projects

	Mt. Hope PV System (2.2kW)	UTT O'Meara PV System (2.2kW)	Gasparillo PV System (2 kW)	Gasparillo Wind Turbine (2.4kW)
Lifetime Energy Produced, kWh	9,978	9,615	7,818	2,975
Cost Savings, TTD	3,692	3,558	2,893	1,101
Quantity of Gas Saved, MMBTU	119	1149	939	359
Gas Savings to TTEC, USD	158	152	124	479
CO2 Saved, kg	6456	6,221	5,058	1,925

Other ENERGY EFFICIENT INITIATIVES



**Induction Street lights
(pilot)**



**Solar Powered
Traffic signs**

Proposed RE targets up to 2025

Dispatchable and Non-Dispatchable RE Energy Sources

	Contribution of Dispatchable Renewable Resources (MW)	Contribution of Non-Dispatchable Renewable Resources (MW)	Total Capacity (MW)
Micro-Installations	1MW (Bio-fuel)	1MW (solar)	2MW
Macro-Installations	2MW (waste to Energy)	4MW (wind)+4MW (solar)	10MW
Total	3MW	9MW	12MW

Contribution of Dispatchable and Non-Dispatchable Renewable Energy Sources to the National RE Target by 2020

	Contribution of Dispatchable Renewable Resources (MW)	Contribution of Non-Dispatchable Renewable Resources (MW)	Total Capacity (MW)
Micro Installations	2MW (Bio-fuel)	4MW (solar)	6MW
Macro Installations	5MW (waste to Energy) 2MW (bio-fuels)	5MW (solar)	12MW
Mega Installation	30MW (waste to Energy)	25MW (wind)	55MW
Total	39MW	34MW	73MW

Contribution of Dispatchable and Non-Dispatchable Renewable Energy Sources to the National RE Target for the Time Period 2021 – 2025


Addressing Climate Change

T&TEC Initiatives

T&TEC has expanded its research into wind energy. Tobago's strong winds made the island an ideal location for the research.

- **Two anemometers** installed in January 2015
- Two locations – **Minister's Bay and Flag Staff Hill**
- Preliminary average wind speed readings – **7m/s**





Addressing Climate Change T&TEC Initiatives

Additional actions taken to better prepare T&TEC and Trinidad and Tobago to withstand the effects of climate change include:

- An RFP has been developed for an ocean current renewable energy project in Tobago
- Early project initiation for the potential of a 1MW Waste heat to Energy plant
- The analysis of a possible 1MW Community Solar Project installation



Thank You